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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04L 12/56, 12/44 — A1

(11) International Publication Number: **WO 97/36406**

(43) International Publication Date: 2 October 1997 (02.10.97)

(21) International Application Number: PCT/FI97/00189

(22) International Filing Date: 24 March 1997 (24.03.97)

(30) Priority Data:
961359 25 March 1996 (25.03.96) FI

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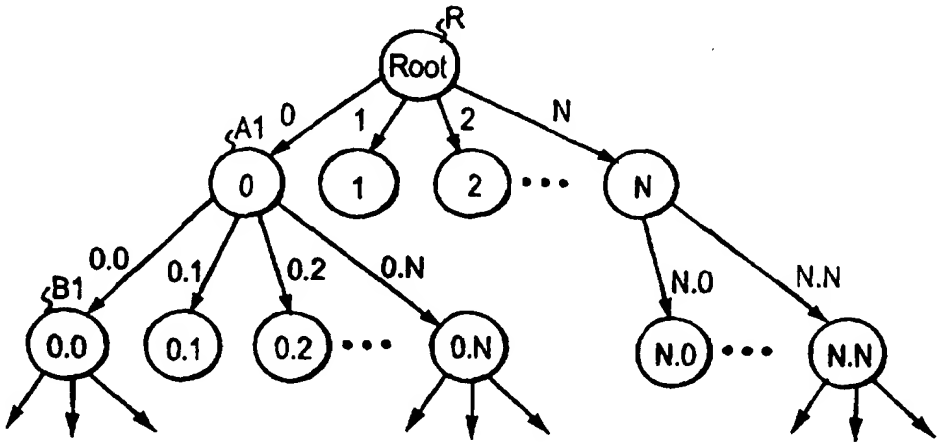
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published

With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: METHOD OF ASSIGNING ADDRESSES IN NODES OF A TELECOMMUNICATION NETWORK



(57) Abstract

The invention relates to a method of assigning addresses in nodes of a telecommunication network. The network comprises several nodes (A...G) connected together by transfer connections so that the network constitutes a tree-like structure, one of the nodes being the root node (A). The nodes transmit to each other signals containing address data used by the nodes. For providing a flexible method easy to use, the root node (A) of the network assigns unique address identifiers to all transfer connections it uses and transmits each address identifier over the transfer connection concerned to its adjacent node, and after having received the address identifier the other nodes of the network a) assign unique identifiers to all transfer connections they use, except to the connection from which they received the address identifier, and b) transmit to each of said transfer connections an address identifier, which comprises the address identifier received by the node itself and the identifier corresponding to said connection, whereby each node assigns its own address by means of the address identifier it has received.

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METHOD OF ASSIGNING ADDRESSES IN NODES OF A TELECOMMUNICATION NETWORK

The invention relates to a method of assigning addresses in nodal devices of a telecommunication network having a tree-like topology, according to the preamble of the attached claim 1.

In this description, intersections of transfer connections of a telecommunication system are called nodal devices or nodes. A node can be any device or equipment that is able to interfere in clock synchronization, e.g. a branching or cross-connect device.

The nodes of a telecommunication network have to know their own addresses (i.e. locations) in the network, because the role of the node in the network (configuration etc.) depends on the address. An address information is necessary also in order that the node may route messages in the network.

Many modern telecommunication protocols use logical addresses not informing unambiguously the physical location of the device. In an internet address, for instance, the host section informs which device is in question in one network, from which, however, no conclusions can be drawn about the physical location of the device in said network. The nodal device shall be assigned a logical address at the installation stage of the network and also when the nodal device is moved to another location in the network. An address is assigned typically by configuring a logical address for each device manually. This can take place e.g. by means of a network management system from a network management workstation of a network operator, or by assigning at first each nodal device at commissioning in a centralized manner an address corresponding to the intended location of the node in the network, and subsequently, each node is moved to its own location.

A drawback of such methods is the great amount of work required, especially when a big network shall be installed (which means a large number of nodes).

Another drawback is the inflexibility associated with such methods in situations of changing the network, because a new address must be configured manually for all such nodes the location of which in the network has changed.

The object of the present invention is to effect an improvement for overcoming the above drawbacks by providing a novel method of assigning

addresses in the nodes of a telecommunication network having a tree-like topology and consisting of point-to-point connections. This object is achieved by means of the method according to the invention, which is characterized in what is described in the characterizing portion of the attached claim 1.

The idea of the invention is to form node addresses in the nodes of a tree-like network structure automatically by assigning unique identifiers to all (point-to-point) transfer connections except to the connection leading to a parent node, and by transmitting to each node situated lower down in the tree-like structure (a child node) an address identifier consisting both of an address identifier received from the parent node and of an identifier assigned to said connection. Because the root node of the network has no parent node, it transmits either an address identifier consisting merely of the identifier assigned to the connection or an address identifier consisting of the own fixed address identifier of the root node and of the identifier assigned to the connection.

When the method according to the invention is used, only the root node of the network has to be assigned an address at the installation of said nodal device (or at some other stage). Subsequently, the other nodes (nodal devices) of the network receive automatically an information of their location with respect to the root node. Accordingly, the address of the node is assigned automatically in a predetermined manner on the basis of the location of the node. Additionally, when devices are changed or new ones are installed, a reconfiguration of addresses is avoided.

The solution according to the invention is very advantageous especially in networks where nodal devices are physically situated at such locations that they are difficult to access.

In the following, the invention and its preferred embodiments are described in greater detail by way of example with reference to the attached drawings, in which

Figure 1 illustrates the general principle of the method according to the invention,

Figures 2a...2f illustrate the operation of the method according to the invention in situations of changing the network,

Figure 3 is a flow chart describing the operation of an individual nodal device,

Figure 4 is a high-level block diagram of those parts of the node which are substantial for the invention, and

Figure 5 illustrates the parts of the nodal device which are substantial for the invention.

The starting point of the method according to the invention is that only the root node of the network is assigned (manually) an address when the nodal device in question is installed. On the other hand, the other individual nodal devices do not need to know their own addresses (i.e. locations) in the network when they are started. The other individual nodal devices know only that they have a number of point-to-point connections to other nodes. One of these connections is a connection to the parent node of said nodal device in the tree structure, but in the initial situation (when a node is started) the node does not need to know, which of its connections is the connection concerned.

The principle of the method according to the invention will be described in the following with reference to Figure 1. Encircled nodes constitute a tree-like hierarchic structure, the root node of which is indicated by reference mark R. Links (i.e. transfer connections) between the nodes are indicated by arrows (the transfer connections are naturally bidirectional, the arrow direction representing transmission of address identifiers). Essential for the invention is that the network constitutes a tree-like hierarchic structure. In other words, the nodes of the network and the connections between them form an acyclic graph (no nodes are produced in the network).

The root node R determines identifiers for each connection e.g. by numbering the connections from zero onwards by using a predetermined method. Subsequently, the root node transmits over each connection the identifier of said connection. In the example case of the figure, integers are used as identifiers, indicated by reference marks 0 to N.

When any node (i.e. node X), except the root node, has started and connections have been established, node X waits for information of its location over some connection. Alternatively, the node may send an inquiry to adjacent nodes. When receiving the location information, node X registers this connection as the connection leading to its parent node in the tree-like network structure. The location information received consists of a set of identifiers, the first one informing over which connection there is access from the root node of the network to next node on the way to node X. The next node informs the connection over which there is access from said next node closer to node X,

etc. In the example of the figure, the identifiers are separated from each other by a dot.

After having received the location information, node X determines identifiers (according to a predetermined method) for all other connections except the one from which the location information was received. Subsequently, node X transmits over each connection a location information consisting of its own location (which is the same as was received by node X earlier) added by the identifier of the connection in question.

Accordingly, the length of the location information received depends on the level of the receiving node in the tree. In the example of Figure 1, for instance, in which the identifiers are integers separated from each other by a dot, node A1 receives location information 0 (zero) from the root node and node B1 at next level receives location information 0.0 from node A1. The location data transmitted are indicated in the figure at the corresponding link.

When new connections then are established to node X, the node provides them with identifiers (numbers them) and transmits location information over them. If a new location information is received from the parent node of node X, it is transmitted further over other connections, provided with the identifier of the connection in question.

Figures 2a...2f illustrate how the method according to the invention functions in a situation in which nodes E, F and G are connected to a network in which nodes A...D are already operational (Figure 2a). The figures show in broken lines the nodes not yet operating. The nodes which operate are shown with an unbroken line, and if an address identifier is denoted inside the node, the node also knows its address (i.e. its location in the network). Accordingly, empty nodes do not know their address yet. From the example, it appears that the method is functioning, even if the nodes start in an arbitrary order.

In the situation of Figure 2a, only node F among the nodes to be added has started, but it is disengaged from the network, because its parent node (node E) has not yet started. In the situation of Figure 2b, node E has started, whereby it receives an address 0.1 from node B. Node E thus knows that said connection leads to its parent node in the network. Node E numbers then all other existing links beginning from zero and transmits over them its own address, after which is added the number of said link. In this example case, there is only one existing link, which thus gets the number zero and over which is transmitted the address 0.1.0. This is illustrated in Figure 2c. After

this, node F knows its address (Figure 2d). In case of Figure 2e, node G starts, whereby its parent node (E) observes the "starting" of the link and updates the list of active links by providing it with a number (one) according to a predetermined numbering method. Node E then sends node G an identifier 0.1.1 (own address added by the identifier of said link). In the final situation (Figure 2f) all nodes know their addresses (locations in the network).

Link identifiers can be assigned in many different ways. It is not worth while to give numbers in the same order as the links start, because numbering does not give any useful additional information then. Points of compass, for instance, could be utilized for the numbering, a link towards north could be provided with number one and a link towards south could be zero. Another alternative, more probable in the practice, is to determine identifiers for instance in such a way that when the device is looked at from a certain direction, e.g. from the front, the identifiers change in the selected direction, e.g. from the left to the right or from above downwards.

The flow chart of Figure 3 illustrates the operation of an individual node. After having started, the node is at stage 31, where it waits for an address message and a link event. The nodes of the network can send their address information continuously, whereby the node receives the address immediately after having started. Link event signifies in this connection a breaking or starting of some link of the node. Stage 31 is the starting stage, where no normal data transmission occurs. When a node observes an address message (stage 32), it stores the received address and the identifier of said connection, assigns identifiers to the other links in operation and transmits addresses to its child nodes (stage 34). Subsequently, the node changes to its normal state (stage 35), where it performs normal data transmission.

If the node observes a link event at stage 32, it updates the linkage listing maintained by it (stage 33) and returns to stage 31, from where there is no access to the normal state until after the address has been received.

In normal state (stage 35), the node is able to observe:

a) a link event of a child node (a link leading to a child node breaks or a link to a new child node is established)

b) a new address message, if changes occur in the network above the node (closer to the root node), or

c) a breaking of a link leading to a parent node.

In case a), the node updates the linkage listing and sends a new address, if a link was established to a new child node (stage 37). In case b), the node moves to stage 34, where it stores the received address and the identifier of the connection in question, determines identifiers for the other links in operation and sends the addresses to its child nodes. In case c), the node moves back to the starting stage (stage 31) to wait for a new address from the parent node.

The node of a network using a method as described above can be e.g. a digital cross-connect device and it can be implemented in many different ways in practice. The way of implementation can vary e.g. according to where a control section of the node (the section that controls the operation of the nodal device) is located. Figure 4 shows a high-level block diagram of those parts of the nodal device which are substantial for the invention. The node (indicated by reference mark N) has in this case four bidirectional connections (L1...L4) to adjacent nodes. In this example case, the control section CTRL of the node is a separate unit, which is common to all interface units IF of the node. The node is connected to the network through the interface units IF, the interface can be e.g. a 2 Mbit/s PCM interface. The transfer mode between the nodes is not essential for the invention; any frame-based method can be used as transfer mode, for instance.

It is essential for the node that the address processing section (control unit CTRL) receives from each interface unit an information of whether said link is in operation (i.e. whether the signal to be received is serviceable). This message is indicated in the figure by reference mark CR (carrier). Reference mark DATA denotes bidirectional data transmission taking place between each interface unit IF and the control unit.

Figure 5 illustrates in greater detail the parts of the control section CTRL which are essential for the invention. The input of the control section is formed by a decoding unit 51, which receives from the interface unit e.g. a frame for which the interface unit has calculated a checksum. The decoding unit decodes from the frames the Protocol Data Units (PDU) contained therein and transmits them further to a connection unit 53. The data units contain information of the type of the frame received, the address possibly included in the frame and the data included in the frame. If the type is e.g. normal (normal frame), the connection unit connects the data units further either directly to

another connection unit or to other parts of the nodal device. In transmission direction, a coding unit 52 generates a frame going out of the data units PDU.

If the received frame contains address information, the connection unit connects the data unit to an address processing unit 54, which stores the received address in a storage area M1, where the node has its own address stored. Additionally, the processing unit stores the identifier of the link leading to the parent node in a storage area M2 and the identifiers of the other links in a storage area M3, which also may contain the information of which link is active/passive at each particular time.

The invention is described above as an embodiment in which the root node transmits to its adjacent node only the identifier of said transfer connection. However, the root node may transmit except the identifier of the transfer connection also its own address. Consequently, if the address of the root node is e.g. zero in Figure 1, it transmits to node A1 the identifier 0.0, which further transmits the identifier 0.0.0 to node B1. Accordingly, the address identifier to be transmitted becomes in this case one level longer than above.

Though the invention has been described above referring to the examples of the attached drawings, it is obvious that the invention is not restricted to that but it can be modified within the scope of the inventive idea set forth above and in the attached claims. It is for instance possible that the address identifier received from the parent node is not used directly as the address of the node itself, but the node assigns its own address according to the address identifier received from the parent node (by processing the address identifier received in a predetermined manner so that the final result is a unique address identifier).

CLAIMS

1. A method of assigning addresses in nodes of a telecommunication network, which network comprises several nodes (A...G) connected together by transfer connections so that the network constitutes a tree-like structure, one of the nodes being the root node (A), according to which method the nodes transmit to each other signals containing address data used by the nodes,

characterized in that

- the root node (A) of the network forms unique address identifiers for all transfer connections it uses and transmits each address identifier over the transfer connection concerned to its adjacent node, and

- after having received the address identifier, the other nodes of the network a) form unique identifiers for all transfer connections they use, except for the connection from which they received the address identifier, and b) transmit to each of said transfer connections an address identifier, which comprises the address identifier received by the node itself and the identifier corresponding to said connection, whereby each node assigns its own address by means of the address identifier it has received.

2. A method according to claim 1, **characterized** in that each node uses the address identifier it has received directly as its own address.

3. A method according to claim 1, **characterized** in that the root node of the network transmits except the address identifier of the transfer connection also its own address to its adjacent node.

4. A method according to claim 1, **characterized** in that integers are used as identifiers.

5. A method according to claim 1, **characterized** in that the identifiers of the transfer connections are formed according to a predetermined principle irrespective of in which order the transfer connections are started.

6. A method according to claim 5, **characterized** in that the identifiers are formed according to the physical location of the transfer connection in the nodal device.

7. A method according to claim 1, **characterized** in that the address identifier transmitted by the node is formed in serial form by sepa-

rating the address identifier received by the node from the identifier of the transfer connection with a predetermined separator.

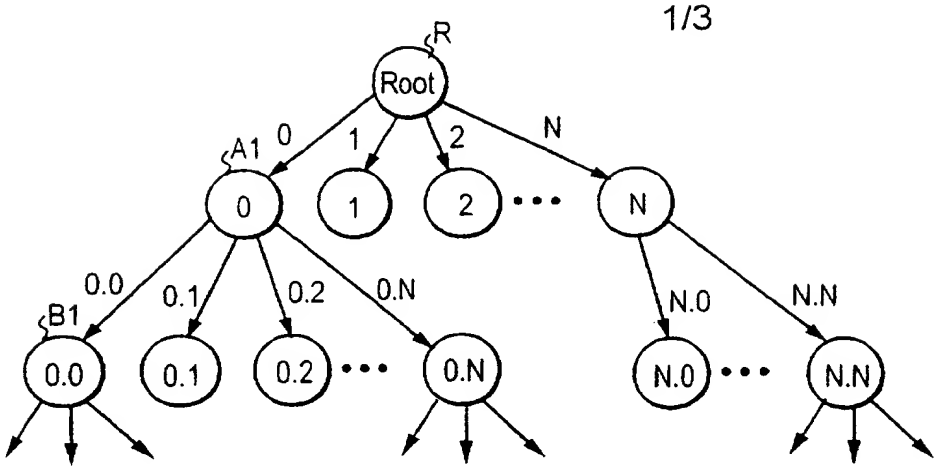

R
Root
A1
0
1
2
N
B1
0.0
0.1
0.2
0.N
N.0
N.N

Fig. 1

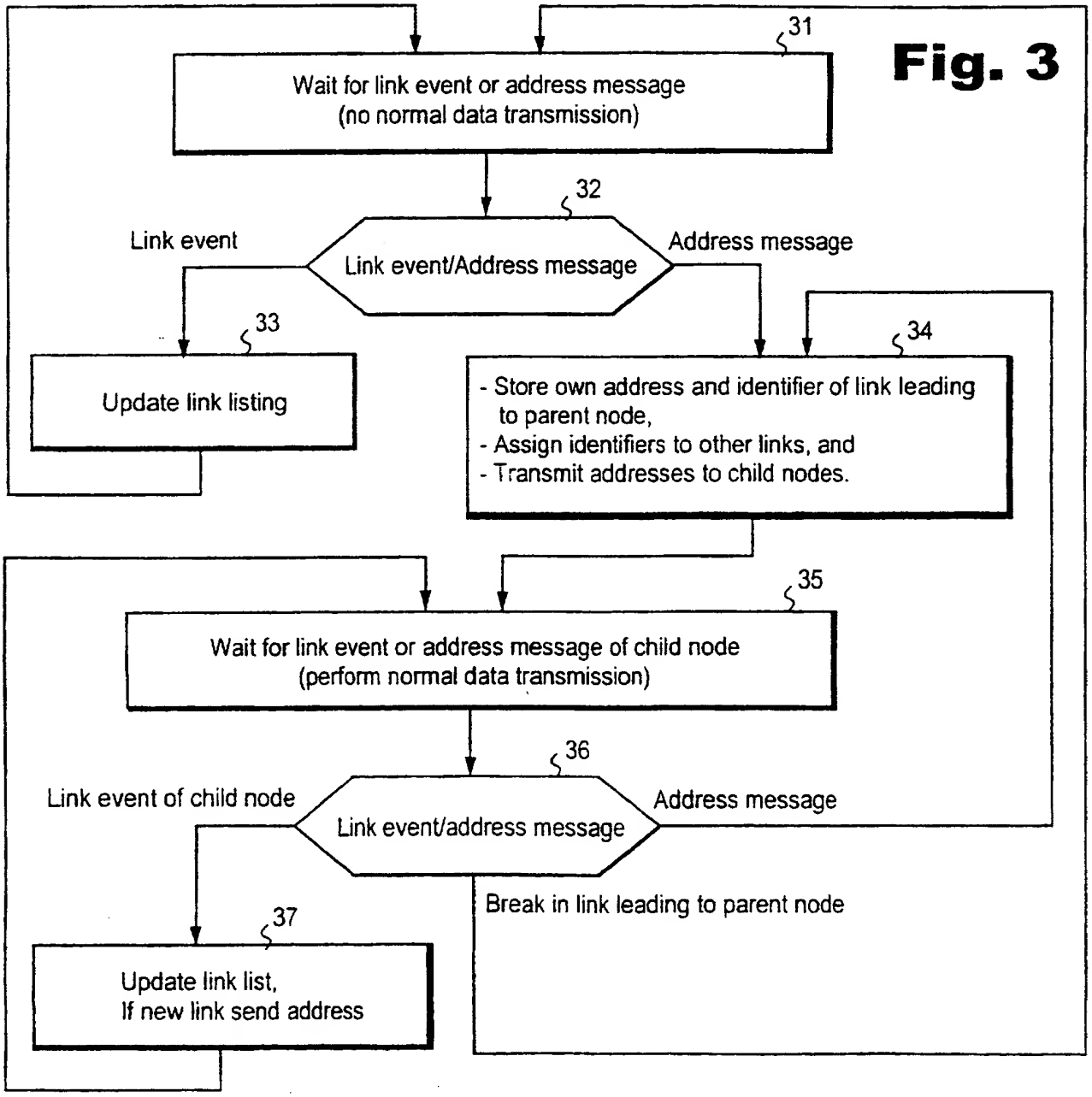

31
Wait for link event or address message
(no normal data transmission)
32
Link event
Link event/Address message
Address message
33
Update link listing
34
- Store own address and identifier of link leading to parent node,
- Assign identifiers to other links, and
- Transmit addresses to child nodes.
35
Wait for link event or address message of child node
(perform normal data transmission)
36
Link event of child node
Link event/address message
Address message
Break in link leading to parent node
37
Update link list,
If new link send address

Fig. 3

Fig. 2a

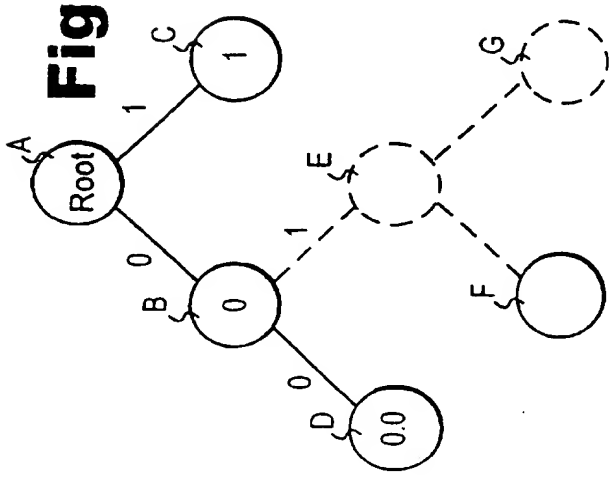


Fig. 2b

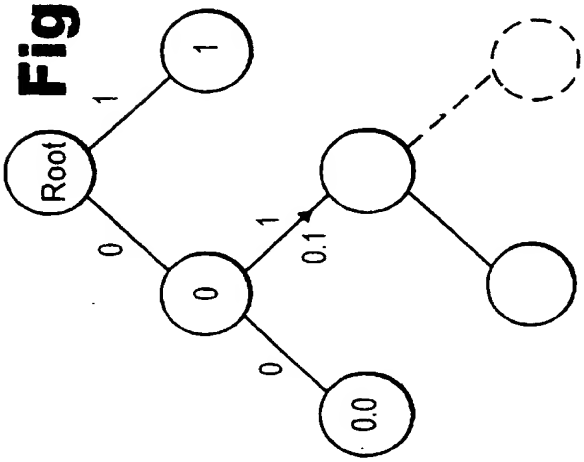


Fig. 2c

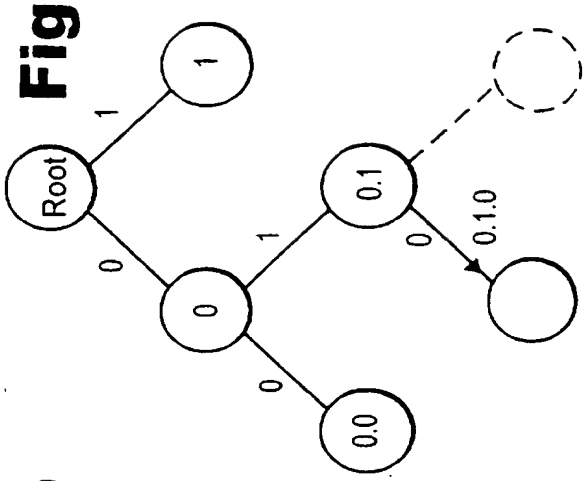


Fig. 2d

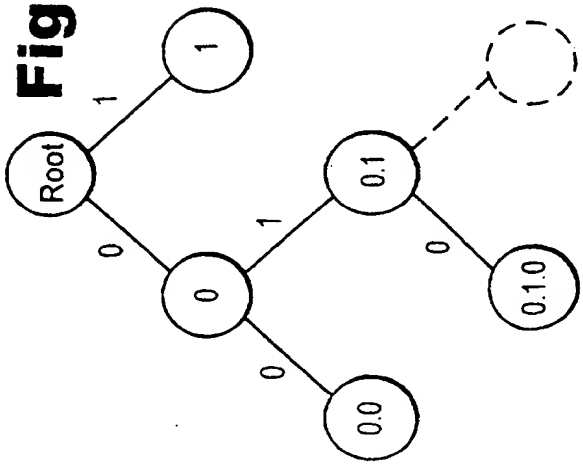


Fig. 2e

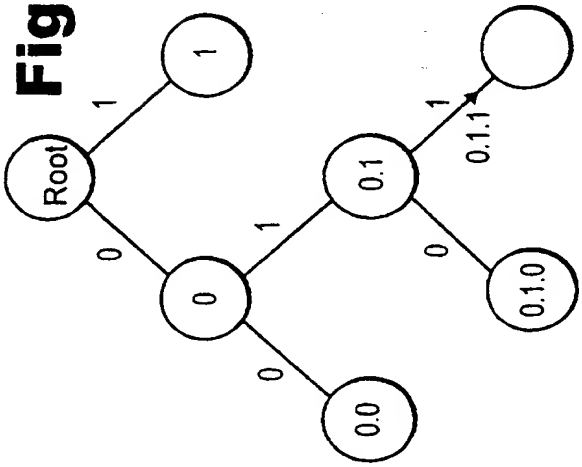
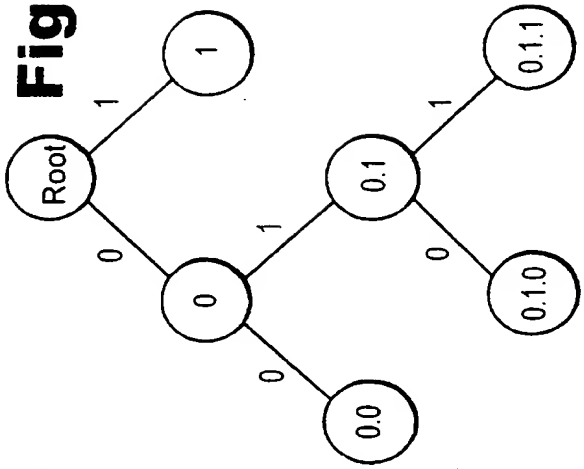


Fig. 2f



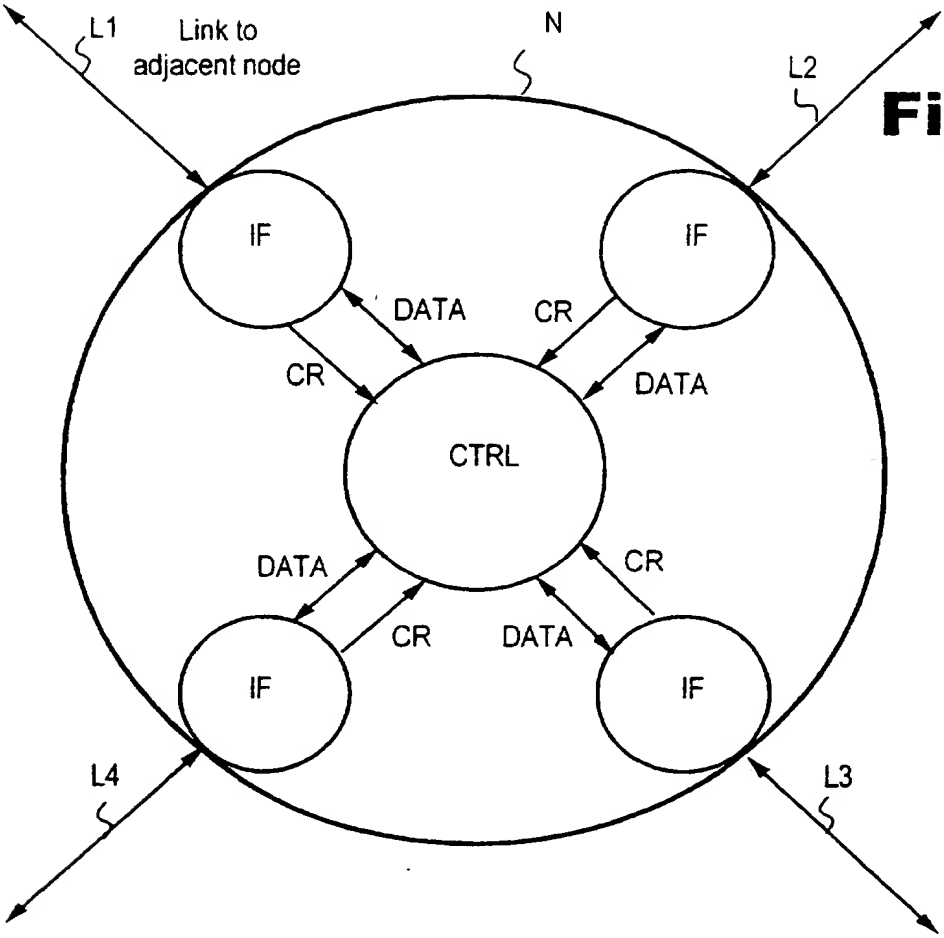

L1
Link to adjacent node
N
L2
IF
IF
DATA
CR
CR
DATA
CTRL
DATA
CR
CR
DATA
IF
IF
L4
L3

Fig. 4

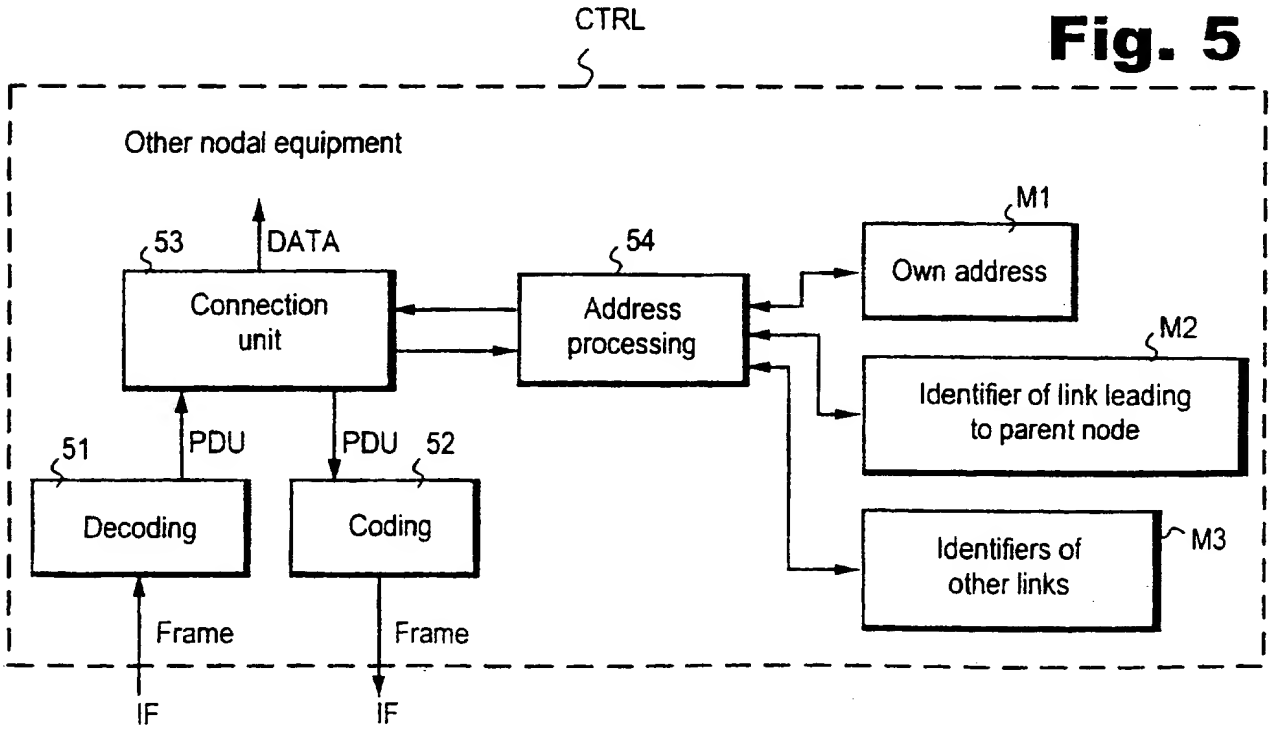

CTRL
Other nodal equipment
53
DATA
Connection unit
54
Address processing
M1
Own address
M2
Identifier of link leading to parent node
M3
Identifiers of other links
51
PDU
Decoding
PDU
52
Coding
Frame
Frame
IF
IF

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 97/00189

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04L 12/56, H04L 12/44
According to International Patent Classification (IPC) or to both national classification and IPC

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EDOC, WPIL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 9702680 A1 (PHILIPS ELECTRONICS N.V.), 23 January 1997 (23.01.97), page 14, line 20 - page 15, line 26 --	1-7
A	EP 0614297 A2 (SONY CORPORATION), 7 Sept 1994 (07.09.94), column 5, line 42 - column 6, line 22 --	1-7
A	WO 9520849 A1 (ZOGHAIB, HUSSEIN), 3 August 1995 (03.08.95), page 5, line 22 - page 6, line 9 --	1-7
A	US 5394556 A (FLORIN OPRESCU), 28 February 1995 (28.02.95), column 9, line 53 - column 10, line 55 --	1-7

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
20 August 1997	21 -08- 1997
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Anders Ströbeck Telephone No. +46 8 782 25 00

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International application No.
PCT/FI 97/00189

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	EP 0275076 A2 (FUJITSU LIMITED), 20 July 1988 (20.07.88), column 5, line 65 - column 7, line 6 --- --------	1-7

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06/08/97

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PCT/FI 97/00189

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